ARCHEOLOGY AND NATIONAL FOREST LAND MANAGEMENT PLANNING

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Preface

During the past few years cultural resources have begun to figure in the land management planning efforts of the National Forest System. Our recognition of several implications of this fact caused us to organize a symposium for the 42nd Annual Meeting of the Society of American Archeology held in New Orleans in the spring of 1977. A paper given by Leslie Wilsesen on the Badger-Jordan Planning Unit is being published elsewhere.

We believe that the next decade will see a wealth of development within the discipline of archeology with land management planning concerns contributing a substantial part. These papers constitute a peek at a future which promises to be both exciting and rewarding for archeologists.

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SOME IMPLICATIONS OF LAND MANAGEMENT PLANNING FOR ARCHEOLOGICAL METHOD AND THEORY

By Dee F. Green and Ernestine Green

Introduction

Archeologists have an overriding concern with the relationships of things in space. We usually define both vertical and horizontal space as important, the former being emphasized in stratigraphic situations and the latter receiving our attention in matters from the measurement of closely associated artifacts and features to settlement studies and regional syntheses covering many square miles. Our concern in this paper will be with the latter phenomenon; that is, very large areas of horizontal space and some of the implications for archeology of dealing with such space.

Dealing with the archeology of very large land areas has not held center stage in the profession. Regional syntheses, (McGregor 1965, Kidder 1962) while dealing in large land areas have seldom dealt with large land areas. The reason, of course, is that due to time and financial constraints there are few empirical studies of large tracts of land. In the 1940's Willey (1953) recognized the need for looking beyond the immediate site and its environs and effectively began "settlement archeology" based on the Viru Valley drainage. Settlement studies (Chang 1968, Trigger 1967, Willey 1956) until recently constituted the major effort dealing with the archeology of large land parcels. Lately the Southwestern Anthropological Research Group (SARG) (Gumerman 1971, 1972) has attempted to look at regional data using comparable collection and analysis formats but that idea does not seem to have caught on elsewhere.

Within the last 5 years, however, the rise of land management planning with the Federal land managing agencies has begun to open opportunities and challenges never before available to the archeologist. The U. S. Forest Service, in particular, has funded a number of archeological studies directly tied to planning of very large blocks of land (300,000 plus acres). The studies reported in this symposium are harbingers of things to come. In the years ahead more archeologists are going to have more opportunities for dealing with the archeology of vast tracts of land. We are already of the opinion that this situation will have profound influence on both the method and theory of our discipline. In the following pages we shall explore some of that potential.

Theory

Cultural Ecology. Generation of both data and theoretical positions regarding the interaction of man and his environment has been voluminous among archeologists. We see this trend continuing and anticipate that the contribution of the archeology of large land parcels will include wider comparative bases making it more feasible to compare development and process in highly similar but scattered environments. Such phenomenon as seasonality might also be better studied over large land parcels and again comparisons made between similar and/or different environments. Planning units will normally include a variety of ecological zones and ecotones; transect sampling will provide data about all of them. Land management plans usually include specialized ecological studies including plant, animal, climatic and hydrological data, etc., thus providing a ready reservoir of information for the archeologist which has been collected by specialists.

One drawback may be a limit on the kinds of ecological areas available in the eastern and midwestern United States due to the comparatively small and scattered amount of public land. In the West, however, the large amount of land in Federal ownership particularly with the Bureau of Land Management and the Forest Service should provide the archeologist with almost any set of cultural and ecological factors he cares to study.

Trade and Migration. Movement of goods and people through space is a phenomena of continuing interest to archeologists. Again, large land parcel studies offer special opportunities for the pursuit of trade and migration studies. Wood (1977) has already used data from the White Mountain Planning Unit, Apache-Sitgreaves National Forest, Arizona, to argue for in-migration to that region during the 1070-1300 A.D. time period. While most planning units will initially permit the development of propositions for testing only at the local level, as contiguous unit plans are studied the investigation of more regionally based ideas will be possible. Again, the western United States should, with its large areas of contiguous surface under Federal control, offer the greatest potential.

Settlement Studies. Settlement patterns are the visible evidence of how groups organize and distribute themselves and their activities over the landscape. It seems self evident that information gathered from large land parcels should contribute greatly to settlement studies generally. But, it should also be possible to test explicit settlement hypotheses such as that offered by Hudson (1969) for rural settlement. Hantman (1977) and Jewett (1977) have already

laid groundwork in that direction but we anticipate that additional testing will be done not only of Hudson's model but of other models put forth by geographers and anthropologists as well. In fact, working with unit plans may well involve archeologists directly in the development of relevant theory and model building which has largely been left to the geographers. Such models could include the greater time depth parameter offered by archeology to say nothing of our concerns with culture change and process. The possibilities in this area seem particularly exciting to us.

Methods

Sampling. Conducting a complete archeological survey of a land parcel embracing hundreds of thousands of acres is an awesome task. Sometime in the next 10-20 years we may see such a feat accomplished but in the meantime it will be necessary to sample land planning units. Despite the clear demonstration of the need for sampling (Binford 1975, Judge 1975, Smith 1977) as a vital part of archeological methods some archeologists (Jelks 1975) remain unconvinced. Such archeologists will effectively remove themselves from consideration for land management studies since the purpose, from the point of view of the land manager, is to have data which will allow good prediction of archeological variables on those units of land not surveyed. "My best guess" data is simply not appropriate when probabilistic data can be collected. Sampling, therefore, will have to be stochastically rigorous rather than grab (Smith, 1977). Defining the target population to be sampled will seldom be a problem since target population will be some unit of space and the spacial boundaries will be administratively set. Sample design will probably undergo little innovation as the mechanics of multi-stage sampling for large land parcels have been essentially worked out by Smith (1977) although not yet fully field tested.

Where we see the greatest potential for many substantial contributions to archeology is in the analysis of data derived from sampling strategies. For example, given a respresentatively drawn sample of 1 percent from, say, 300,000 acres it should be possible to formulate any number of worthwhile testable propositions about the archeology on that land parcel. These propositions could then be tested by drawing additional samples. Such strategies would, in our opinion, contribute much more to our understanding cultural-historical processes than propositions derived from nonrepresentative samples as is so often the case in current practice. Plog (1977) and his students have already begun to make such contributions in their work on the White Mountain Planning unit.

Surface Data. One obvious problem with doing the archeology of large land parcels is that most initial work will consist of surface survey. Most agencies funding such projects are primarily interested in locating the cultural resources rather than doing very much investigation of the resource *per se*. Thus, most funding will be directed to survey rather than excavation, although some limited testing will probably be done. We, therefore, look for methods of improving the handling of surface data. Such developments will undoubtedly include in-the-field analyses of the type already undertaken by Morenon (1976) and more sophisticated use of statistical methods. We can look for developments in surface sampling techniques as well as greater sophistication in field and laboratory analysis. Perhaps the development of light weight analytical field equipment will occur along with better use of such already standard items as cameras and aerial photos.

Data Comparability and Standardization. The archeologist attempting to write a regional summary has always been plagued with the problems of data comparability and standardization. When one draws data sets from various investigators with different problems and who use different methods there is a continuing problem of knowing when one is looking at identical pieces of data and how different apparent differences in the data really are. Even the supposed standard ceramic typologies are fraught with problems and contradictions as most students who have dealt with pottery are aware.

Research designs which cover large land areas will make possible the gathering of data in comparable if not standardized categories as well as the consistent application of analytical techniques to that data. If a single or if several archeologists working on land management plans over very large contiguous areas can adopt a uniform research design with attendant collection and analysis techniques somewhat after the manner of SARG (Gumerman 1971, 1972), then the basis for synthesis over that area will have a much higher degree of confidence than has ever been possible. We look for such developments to occur.

Data Manipulation. Multi-spectral scanners, satellite imagery, computers, and other sophisticated devices are already being used by archeologists to some degree. With planning unit studies accumulating large data bodies we see an increase in both the use and sophistication of highpowered data manipulation devices. The principal use will probably be for data reduction to a more manageable form, at least initially. Acutal analysis, however, is already occurring and will play an increasingly important role. Actual survey may eventually be done by remote sensing equipment. The senior author and Fred Plog were discussing just such a

possibility recently when Plog suggested, and Green agreed, that we will live to see the day when survey is done by an archeologist sitting at a cathode ray console with direct link to a satellite which as it passes over a particular piece of ground scans the ground with sufficient resolution to make site recognition possible. As the archeologist recognizes the site he pushes a button which automatically records the exact geographical provenience of the site and provides satellite imagery of same. Subsequent field checking of the site may or may not be necessary but covering ground devoid of sites would be unnecessary.

Conclusions

We have briefly shown how such theoretical topics as cultural ecology, migration and trade, and settlement studies as well as methods such as sampling, surface data collection, data comparability and standardization and data manipulation may be influenced in the years to come by an increase in the doing of archeology on very large land parcels. We feel that, for the most part, archeologists have concerned themselves with rather small land units and this has influenced their thinking. Synthetic treatments of the archeological record in a region are usually patchworks from the perspective of small land units rather than intergrated records based on data of wide contiguous areall extent. Even the synthesis of Arizona by Martin and Plog (1973) which sets its archeological discussions in four broad environmental zones is forced to rely on nonrepresentative data from those zones.

The most serious fault with all regional syntheses to date has been that they were concocted for nonrepresentative data. Examples include the differences in opinion on Great Basin adaptations during the archaic between Heizer and Jennings (Bettinger 1977) and the tendency among some Southwesternests to view things from the perspective of the "great centers" such as Mesa Verde or Chaco Canyon. As Jennings (1966) has so astutely pointed out, most of the people did not live at Mesa Verde.

During the next 15-20 years archeologist will have a unique opportunity to provide a sound representative sample of the archeology of the West by participating in land management planning studies. We believe that the next couple of decades should provide some exciting developments in both theory and method among archeologists.

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CULTURAL RESOURCES AND LAND USE PLANNING: ARCHEOLOGY AND GRID, PHASE I

By Kent A. Schneider and Roger S. Frantz

Introduction

Rapid loss of cultural resources as a consequence of population expansion and industrial development has necessitated the expeditious location and assessment of sites within the United States. For the Forest Service, charged at large with the broad management of hundreds of thousands of acres of basically rural land, the need to identify archeological sites in a rapid and thorough manner has reached the core of its planning mandates. The Chattahoochee National Forest, Georgia, views site identification and assessment needs both in light of the legal requirements for inventorying cultural resource values and, more importantly, as elements essential in generating orderly and systematic plans for managing specific areas of land. Until recently, however, there was no system through which diverse cultural resources on the Forest could be identified and effectively integrated into the planning process.

The present paper describes a means by which archeological sites can be located, inventoried and integrated into the planning process. The means, called GRID, is a computer mapping system which sets the stage for inventorying sites and predicting their locations by any of a number of available computer programs.

The Problem

Forest Service concerns include development and maintenance of wildlife, timber and recreation areas within which occur the broad spectra of cultural resources. These must be evaluated prior to ground disturbing activities as required by Federal law. The first order must be site location. During the past two decades, there have been significant advances in the manner in which sites are surveyed (e.g., Lee 1976; Ray, et al., 1976). It is not our intent to critique these advances; rather, we note only that throughout these studies there are environmental commonalities which seem to have set the stage for models predicting site locations. In addition to the all important spatial dimension, significant associations include landform, elevation, vegetation, soils, slope and water source. A system which allows combining and manipulating these variables with known archeological sites and which graphically plots these in 10-acre cells imposed over an 800,000-acre Forest should enable site prediction as well as generation of an atlas depicting site type and loci. For archeology, the Forest Service seems to be an untapped resource: through its land management mandates, such a system has been developed but for purposes other than archeology.

GRID and CONGRID

As in archeology, a continuing problem for land managers is the comprehension of the variabilities that are characteristic of any large geographic area. Differences in slope, aspect, soil, and vegetation have an influence on management activities. Understanding the implications of these site characteristics can result in the success or failure of a project.

Many methods have been developed to analyze and interpret--in an orderly fashion--the variabilities of a given area. The most common of these is the graphic overlay system prescribed by Ian McHarg in "Design with Nature." This system consists of a series of overlays over a base map. Each overlay represents a set of environmental characteristics and interprets their suitability for man's use of the area. Interpretations are represented in various tones of gray with negative values as dark tones and positive values in clear or light tones. As a series of overlays are developed and placed over a base map, areas of varying levels of suitability are visually depicted.

Although this system is highly successful, it does have its drawbacks. The base maps and overlays are often large and difficult to handle. If many overlays are developed, it is difficult to interpret the data. Making the overlays and updating any changes is time consuming.

Computer mapping sytems offer an alternative to this process. The two major systems are the LINE POLYGON and GRID system. With the LINE POLYGON system, areas with similar charcteristics are outlined on a base map. The boundaries of the polygon are digitized and stored in data files. Interpretation of this data is accomplished through the use of a computer and a new map is printed with the use of a digital plotting devise. Although this system is highly accurate, it requires expensive equipment and highly trained personnel to operate.

GRID systems divide maps into small rectangular cells of equal size. Cells which have the same attributes are identified with identical codes. Learning the operation of GRID systems is quite easy and these are relatively inexpensive to operate. One common system in the (Harvard) GRID mapping system, developed in 1963 by David Sinton and Carl Steinitz of the Harvard University laboratory for computer graphics and spatial analysis.

With any computer mapping system, three steps are essential: (1) providing the computer with data in a form acceptable to the machine (input); (2) the manipulation of the data and preparation of a map by the computer memory (processing); and (3) the actual display of a map by the computer (output).

Identification of the location of any point on a map is necessary with any mapping system. GRID accomplishes this with the GRID Coordinate or X-Y Reference System. As shown in figure 1, any cell is identified by its row and column number and is unique to every cell. If a number of overlays are desired, any cell, identified by its row and column number, will represent the same area on every overlay.

To enable the computer to process data, the data must be in a machine readable form. Usually, characteristics are delineated on a base map as shown in figure 2. A legend suitable to the user's needs is developed which establishes a numeric value for each characteristic. If this base map is to represent vegetation, the following legend would be developed:

1 = Dogwood
2 = Oak
3 = Pine
4 = Grassland

An overlay is placed over the base map and coded according to the values on the base map. The data is now in a machine-acceptable form and is ready for key punching.

The primary advantage to GRID is its ability to assist planners and managers in doing suitability and impact analyses by intersecting overlays. The basic concept of GRID is illustrated in figure 3. For example, the manager has determined that an activity is suitable only on clay soils with dogwood trees. By using the vegetation base map with "4'S" showing cells with dogwood trees and soil data base maps with "7'S" showing the cells with clay soils, GRID manipulates the data to find the cells where these two conditions intersect and prints out a new map showing the location of these conditions.

The results of intersections are provided on a line printer as shaded maps usually with low values as light areas and dark areas as high values. Statistical data is provided in the form of global counts of all cells with identical codes and is shown on the printouts as total cell counts, acres and histograms.

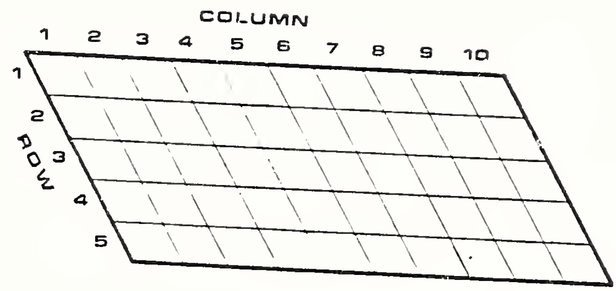


Figure 1

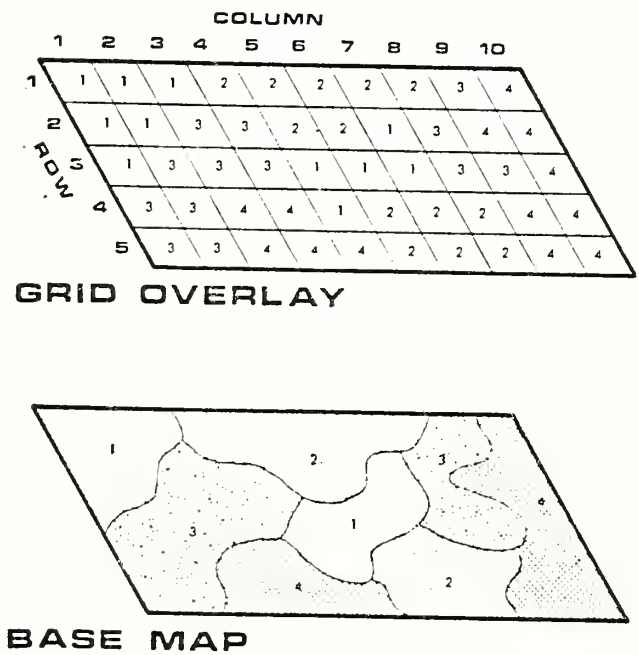


Figure 2

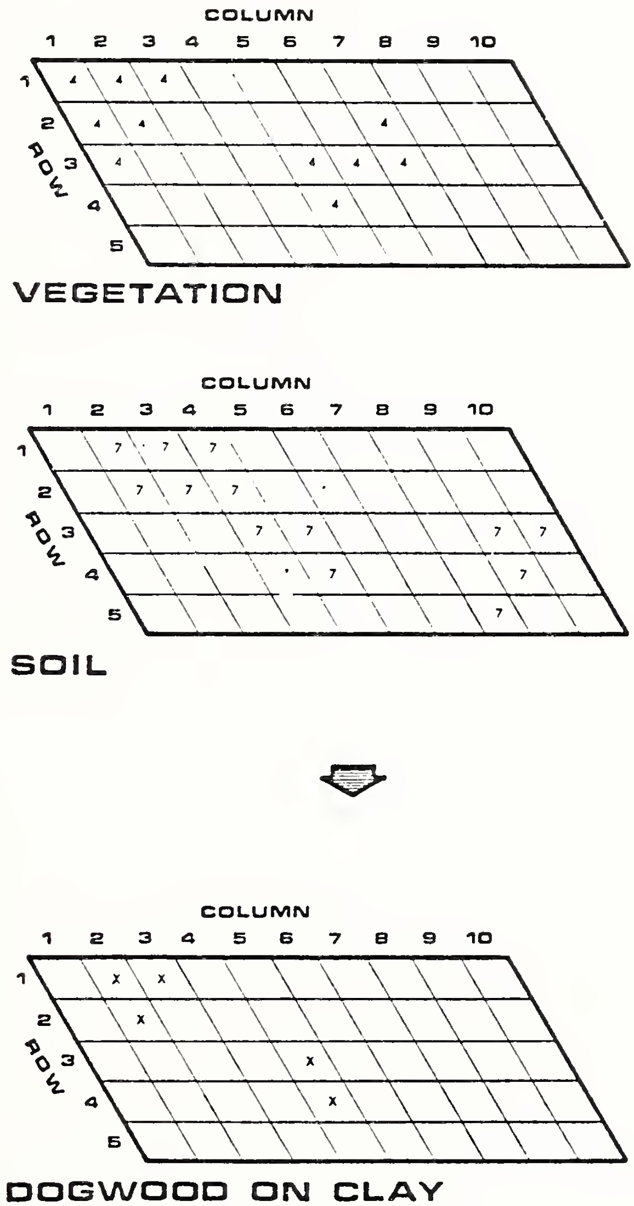

COLUMN
ROW
VEGETATION
COLUMN
ROW
SOIL
COLUMN
ROW
DOGWOOD ON CLAY

Figure 3

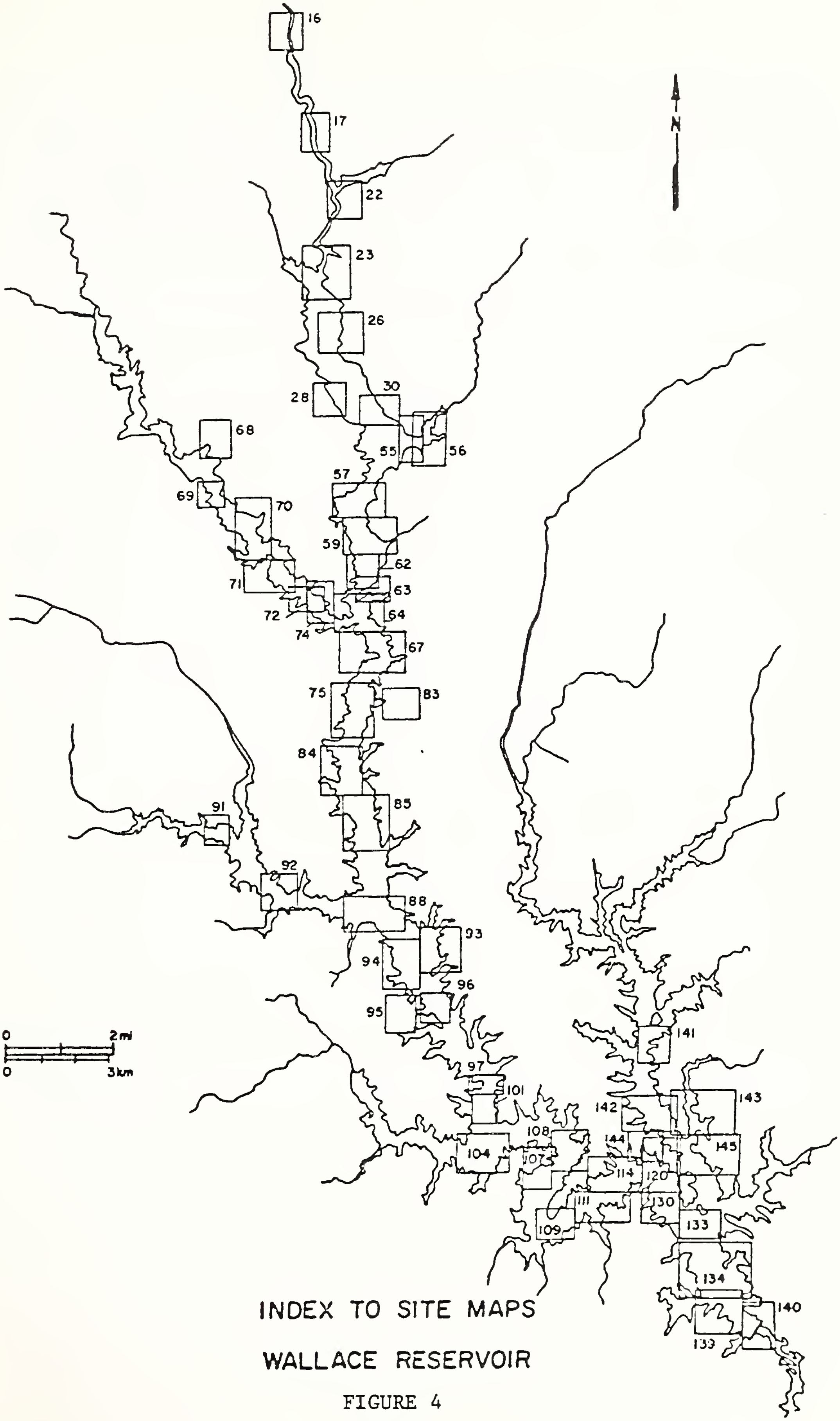
CONGRID, an expanded version of GRID, is being used by the planning staff on the National Forests in Georgia as an aid in developing unit plans. CONGRID[1/] is used to identify areas of timber harvesting, road corridors, and recreation development sites. The impacts of proposed management actions are analyzed by intersecting proposed actions with existing environmental factors such as soils and water overlays. The soils overlays are based on the Forest Service soils resource inventory. These overlays are landform, soil texture, water regime and soil modifiers. Vegetation overlays include Forest type (tree species), stand age, and stand condition. The water overlay shows streams and standing water bodies. Other overlays show roads and trails, developed recreation sites and political boundaries. With the addition of archeological site identification and location overlays, these intersections will show the location and degree of impacts which will aid in adjusting the proposed actions to lesson environmental impacts.

Discussion

Two levels of analysis are considered essential in testing the feasibility of locating and inventorying cultural resources using GRID. Level I involves an examination of the relationships between GRID variables and archeological sites known in a given area. Level II involves the addition of archeological data to GRID and the attendant addition or deletion of variables derived from a study of the results of Level I. Due to restricted use of GRID on Forest Service adminstered lands, Level I has been difficult to attain.

For the initial test of Level I, Green County, Georgia (nine percent of which is administered by the Forest Service) was selected as the study area. The area is well drained by three major rivers and, judging by the number of recorded sites, was ideally suited to exploitation of the flora and fauna by early inhabitants. The ebb and flow of hostilities and reprisals between Creek Indians and Europeans is well documented. Historically important portions of the County will soon be inundated by a reservoir. As a result, a good deal is known about the history and preshistory of the area (figure 4).

[1/] CONGRID (conversational GRID) and DBMANG (Data Base Manager--GRID) is a modification of (Harvard) GRID prepared for the Southern Region, U. S. Forest Service by Rick Hokans, the University of Georgia, School of Forest Resources, Athens, Georgia.



INDEX TO SITE MAPS

WALLACE RESERVOIR

FIGURE 4

The sites included 175 prehistoric and 25 historic archeological resources. An additional 60 locations selected randomly as points having "no sites" completed the population. Using both discriminate analysis of the raw data and a smoothing principal component analysis, 10 GRID variables were compared against data pertaining to the sites. The variables are briefly described below:

1. Landform: Includes floodplain, stream terrace, upland flat, ridge, and steep side slopes and narrow floodplains;

2. Source of materials: Soils formed from acid crystalline rock, basic crystalline rock, mixed acid and basic crystalline rock, acid crystalline rock very high in feldspar, carolina slate, old alluvium, and recent alluvium;

3. Water or soil moisture regime: The amount of water which a soil can hold, to include classes waterlogged, wet, moist, dry, drought;

4. Slope

5. Modifiers: Unique surface or subsurface features which by their presence affect management, to include passive and active erosion, abundance of rocks, excessive water;

6. Aspect: Compass points on which slopes face;

7. Elevation

8. Vegetation

9. Stream Distance

10. Stream Order

Results and Conclusion

As of the present writing, all hoped for results are not in, and so it goes with computers. Table 1 summarizes our available data and is suggestive.

	175 PREHISTORIC	24 HISTORIC	60 NO SITES
No. of sites	175	24	60
	PREHISTORIC	HISTORIC	NO SITES
Principal Component, all data	63%	58%	77%
Exclude Aspect/Elevation	63	54	73
Exclude Stream Dist/Stream Order	59	54	77
Exclude Modifiers/Elevation	54	50	72
Exclude Slope/Aspect/Elevation	54	50	73

Table 1. Comparison of principal component analysis of all data with selected excluded variables.

Principal component analysis of all data allowed correct identification of the location of 63% of the known prehistoric sites, 58% of the known historic sites, and 77% of the class "no sites." By inspection of the excluded variables, it appears that aspect and elevation play a lesser role in site location prediction. However, we do not know the effect of the five remaining variables and can of course draw no conclusions. We suspect these five are critical. Ray's Archeological Sample Survey Of The Caddo Planning Unit concluded that "The three most important variables were slope gradient, distance from water and site altitude . . ." in predicting the locations of archeological sites (1976:26-29). Similarly, in his Settlement Pattern During the Late Mississippian Period In Piedmont Georgia, Lee (1976) noted that distance from water (up to 300 meters), landform and soil type were essential to validity in prediction.

We anticipate that the integration of completed Level I data into GRID which allows tight control of space while manipulating variables will benefit management and archeology. In particular, generating archeological survey methods--whether vector, transect, random total, or other--from GRID will increase predictive precision.

Acknowledgements. Through the interest and efforts of Richard (Rick) Hokans, the present study is being guided and shaped. We appreciate his concern.

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Appendix A

Legends for GRID Maps Chattahoochee-Oconee National Forest

Timber Compartment and Stand Number

LEGEND

First 3 Digits = Compartment Number
Last 2 Digits = Compartment Numbers

Ref. CISC Files of September 1975

Special Symbols

LEGEND

0 = None
1 = Active Gully
2 = Erosion Critical
3 = Soil Depth Critical
4 = Stones Critical
5 = Bedrock Outcrop
6 = Wet Spots

Landform

LEGEND

1 = Flood Plain
2 = Stream Terrace
3 = Upland Flat
4 = Ridge
5 = Droughty

Source of Material

LEGEND

1 = Acid Rocks Dominant
2 = Basic Rocks Dominant
3 = Mixed Acid and Basic Rocks
4 = Recent Alluvium
5 = Old Alluvium
6 = Mica Schist
7 = Feldspar
8 = Carolina Slate

Water Regime

LEGEND

1 = Waterlogged
2 = Wet
3 = Moist
4 = Dry
5 = Droughty

Modifiers

LEGEND

0 = None
1 = Erosion
2 = Erosion Critical
3 = Soil Depth Critical
4 = Stones Critical
5 = Excess Water

Roads

LEGEND

1 = Primitive
2 = 1 Lane Graded and Drained
3 = 2 Lane Graded and Drained
4 = 1 Lane Soil or Aggregate
5 = 2 Lane Soil or Aggregate
6 = Paved

Trails

LEGEND

1 = General Purpose
2 = Recreation
3 = Appalachian Trail
4 = Bartram Trail
5 = Uninventoried

Water

LEGEND

1 = Named River
2 = Named Stream or Creek
3 = Standing Body of Water (18 acres)
4 = Class 1A (Primitive Trout)
5 = Class 1B (Native Brook Trout)
6 = Class 1AB (Primitive, Native Brook Trout)
7 = Class 2 (Stocked Trout Stream)
8 = Class 2A (Saturation Stocked Trout Stream)
9 = Class B (Put and Take Fishery)

Special Uses

LEGEND

1 = Experimental Area
2 = Residence
3 = Park/Picnic Ground (Nonuses)
4 = Cemetary
5 = Antiquity
6 = Cultivation
7 = Military Training
8 = Industrial Right-of-Way
9 = Grazing
11 = Uses Campground
12 = Historical Area
13 = Archeological Area
14 = Uses Picnic Ground
15 = Special Management Area

Forest Types

LEGEND

03 = White Pine
04 = White Pine-Hemlock
05 = Hemlock
06 = Hemlock-Hardwood
07 = White Pine-Yellow Poplar
08 = White Pine-Chestnut Oak
21 = Longleaf Pine
22 = Slash Pine
31 = Loblolly
32 = Shortleaf Pine
33 = Virginia Pine
38 = Pitch Pine
39 = Table Mountain Pine
50 = Yellow poplar
51 = Post Oak-Black Oak
52 = Chestnut Oak
53 = White Oak-Red Oak-Hickory
54 = White Oak
55 = Northern Red Oak
56 = Yellow Poplar-White Oak-Northern Red Oak
58 = Sweet Gum-Yellow Poplar
59 = Scarlet Oak
61 = Swamp Chestnut Oak-Cherry bark Oak
62 = Sweet Gum-Nuttall Oak-Willow Oak

41 = White Pine-Northern Red Oak-White Ash	63 = Sugarberry-American Elm-Green Ash
44 = Shortleaf Pine-Oak	64 = Laural Oak-Willow Oak
45 = Virginia Pine-Southern Red Oak	65 = Overcup Oak-Water Hickory
46 = Loblolly Pine-Hardwood	72 = River Birch-Sycamore
47 = Slash Pine-Hardwood	73 = Cottonwood
48 = Pitch Pine-Oak	74 = Willow
	75 = Sycamore-Pecan-American Elm

<u>Archeology Sites</u>

LEGEND

SITE TYPE		SITE CONDITION
HISTORIC	PREHISTORIC	
01- = Domestic	51- = Habitation	1 = Unaltered
02- = Industrial	52- = Quarry	2 = Altered
03- = Cemetery	53- = Workshop	3 = Destoried
04- = Wood Tressel	54- = Burial Mound	4 = Excellent
05- = Trail	55- = Cemetery	5 = Good
	56- = Enclosure	6 = Fair
	57- = Earthwork	7 = Deteriorated
	58- = Petroglyph	8 = Ruins
	59- = Fish Weir	9 = Unexposed
	60- = Camp	
	61- = Trail	
	62- = Kill	

AN ARCHEOLOGICAL SAMPLE SURVEY OF THE CADDO PLANNING UNIT, OUACHITA NATIONAL FOREST, ARKANSAS

L. Mark Raab

Introduction

The following report presents the results of a statistical sample survey of the Caddo Planning Unit of the Ouachita National Forest (108,000 acres/169.22 mi^2) in Montgomery, Pike, Garland, and Hot Springs Counties, Arkansas. The Caddo Unit is one of twelve planning units of the Ouachita National Forest and is located on the central south periphery of the Forest (Fig. 1 and 2). The report is a summary of field and laboratory studies (U.S. Forest Service Contract No. 38-2874) conducted by the Arkansas Archeological Survey (Ray, Raab and Cochran 1976) between March 1 and September 10, 1976 at the request of the U.S. Forest Service.

The project area is located in the northern Ouachita Mountains of west central Arkansas and eastern Oklahoma. This is an area of narrow stream valleys between rugged slopes and ridges. Except for the larger parcels of bottomland, which have been cleared for pastures and fields, the area is generally heavily wooded in stands of pine or mixed pine-hardwoods. Virtually all of the land controlled by the Forest Service in the Caddo Unit is restricted to forested hillslopes, ridges and lesser stream drainages.

Study Goals

The study goals of the archeological sample survey in the Caddo Unit were developed in a research proposal which was approved by the U.S. Forest Service prior to the initiation of fieldwork. Briefly, the major goals of the sample survey were to determine:

1. the probable locations of cultural resources in areas not directly examined (i.e., observed) as a result of the sampling procedure.

2. the probable size, complexity, and function of cultural resources in areas not directly examined as a result of the sampling procedure.

3. the need for further sampling and/or intensive archeological surveys with the Caddo Unit.

Figure 1. Ouachita National Forest Location.

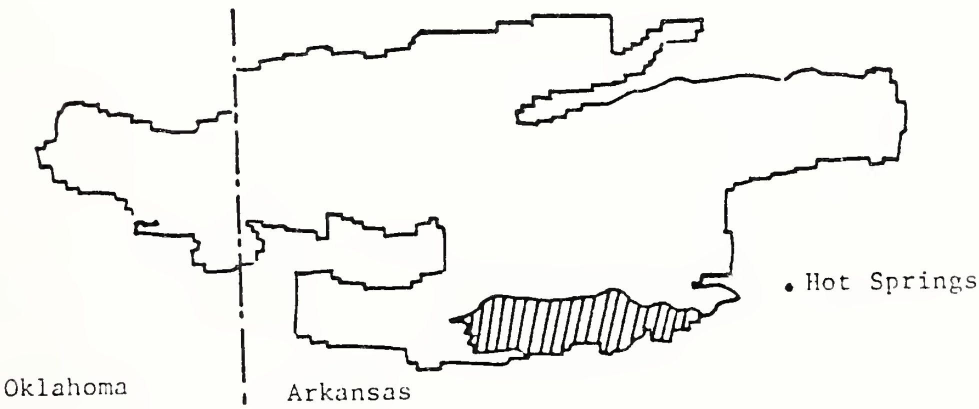

Figure 2. Location of Caddo Planning Unit of the Ouachita National Forest.

4. a time and cost estimate to accomplish additional research, should "3" above be recommended.

Essentially, the archeological sample survey attempted to determine the probable location and significance of archeological resources within the Caddo Planning Unit. The key concept here is "sampling." The survey of archeological resources was based on a combination of judgmental and statistical techniques (Ray, Raab and Cochran 1976: Chapter 2) designed to provide reliable information at reasonable cost. This information was to result in reliable predictions about the location and significance of archeological resources, thus serving the needs of both Forest managers and archeological scientists. Predictive information about archeological resources will serve Forest managers by allowing more accurate estimation of impacts on archeological resources, resulting in an economical but effective means of assessing management needs. On the other hand, reliable information on archeological resources will benefit archeological scientists in their efforts to build a systematic body of knowledge about past human behavior.

Sampling in the Caddo Unit

Since the results of the Caddo Unit survey depend upon sampling procedures, it may be helpful to present a brief discussion of the types of sampling employed in the survey.. Three types of sampling were employed simultaneously: (1) *statistical-geographical sampling;* (2) *statistical-environmental sampling;* and (3) *judgmental sampling*. These three types of sampling are not mutually exclusive of one another but each contributes a specific kind of information about archeological resources and may be considered separately:

(1) *Statistical-geographic sampling*. In one sense, archeological sample surveying may be considered a problem of sampling geographic space. In situations where virtually nothing is known about the spatial distribution of archeological sites, it may be useful to treat a study area as an undifferentiated geographic space. Since archeological sites occupy geographic space, sampling of this space will produce a sample of archeological sites contained therein. Unfortunately, it is difficult to produce an accruate picture of geographically and culturally diverse archeological remains based on a small sample. This is so because archeological remains occupy a minute fraction of any resonably large land parcel, and simply sampling geographic space at a small fractional level (1% for the Caddo Unit) may not be an efficient means of locating archeological remains. For this reason geographic sampling was conducted in *successive stages* in order to incorporate information from previous sampling, and in conjunction with the second type of statistical sampling, *statistical-environment sampling*. Both these samples were designed to improve the effectiveness of statistical-geographic sampling.

(2) *Statistical-environmental sampling.* Like statistical-geographic sampling, statistical-environmental sampling was achieved by the use of *sampling transects* selected statistically from sections of the township-and-range blocks within the project area (Donaldson 1975). The transects were sampling strips 50 m wide and of variable length and directional orientation. The geographic space encompassed by the transects was examined by a field crew of four persons for archeological resources. At the same time, information about the environmental setting of the transect was recorded if archeological resouces were discovered. In addition to the fact that the sampling transects represent a purely spatial sample, they also represent a *statistical sample of environments in the Caddo Unit.* This fact has particular archeological importance because of the close interrelations of prehistoric peoples and their environments. Unlike modern society, prehistoric people generally did not have the capability of transporting large quantities of resources from the point of resource acquisition to distant points of consumption. Consequently, prehistoric people tended to locate their camps and living areas near the resources they needed. The result is that one can construct effective predictions about the locations of archeological sites if appropriate information can be collected about the resources a certain prehistoric people may have needed. Fortunately, some commodities, such as water and plant and animal food sources, were universally needed resources and information can profitably be collected on these variables in any environmental setting.

The environmental sampling in the Caddo Unit was designed to obtain basic information on environmental features which may have conditioned prehistoric settlement locations. In this endeavor we believe the sampling program was highly successful. Several types of environmental features were associated with archeological sites and this information should be helpful in predicting site locations and, to some degree, site functions.

(3) *Judgmental sampling.* Constant evaluation of study results is a regular feature of all archeological studies. Regardless of the methods used, be they statistical or otherwise, archeological interpretations must rest on the judgments of archeologists. These judgments should, of course, be informed by respresentative data but all study results need to be constantly evaluated in the light of archeological experience and expertise. During the Caddo Unit survey, every effort was made to combine past experience with statistially based methods. Archeologists have long recognized, for example, that certain physiographic features and proximity to important natural resources such as water are important factors affecting the location of archeological sites. For these reasons, the field crew examined areas between or adjacent to the sampling transects where previous experience suggests that sites might be found. This approach provided important comparative and contrastive information with

regard to the statistical sampling methods. Again, it should be clearly recognized that statistical methods and judgmental sampling are not alternative approaches, but are most productive when used in combination. Judgmental sampling and statistical sampling were used simultaneously, in combination, throughout the sampling stages in the Caddo Unit survey.

Sample Survey Results

Based upon the results of the sampling program, two types of predictive models of site location have been generated: site density approximation and environment-site type correlations.

Site Density Approximation. Although several environmental factors (discussed below) hindered the statistical-geographical sampling strategy, the basic results of that phase of sampling have provided meaningful and useful data for scientific and management purposes. The most important of these data are incorporated in unit-area site density maps (Maps 13). These maps reflect site densities for all time periods and all classes of sites. Estimations were based on sites found off, as well as on, transects with sections where sites were located used as data points. The density maps illustrate areas of highest probable site densities based on the data acquired during the survey by printing out contour lines similar to the geographic contour lines of a topographic map. The program utilized was GIPSY 4 which was developed by the Department of Geography at Arizona State University.* Map 1 was generated from the locations of all sites found on the transects of Stage 1 sampling. Map 2 was generated from the locations of all sites, on and off transects, discovered during all three stages of sampling.

The areas which would be analogous to higher elevations on geographic contour map respresent the "hot spots," or the areas of the highest probable site densities. As can be seen, the "hot spots" indicated at the end of the first stage and again at the end of the sampling are closely related, except for a new area of relatively high density which appears near the north-central boundary of the planning unit on Map 3. This tends to suggest a consistent trend in the results of the sampling strategy. Both the transect-located sites and sites located off the transects indicate relatively high densities of sites in the eastern half of the project area. These high-density areas should be a primary concern for management purposes. The higher density of sites in the eastern sector may be due not only to the availability and accessibility of novaculite (cryptocrystaline stone) outcrops but also to the generally more rugged and drier terrain in the western sector.

Environmental-Site Type Correlations. The correlations achieved in the model described below resulted from statistical-environmental as well as judgmental sampling. The data covered in the field were subjected to two types of statistical tests (chi-square and Spearman's Rank Order Correlation Coefficient) which demonstrated the statistical association of several environmental variables and archeological site types.

Statistical Analysis of Environmental Variables

The primary environmental variables utilized in this analysis were *altitude of the site, gradient* (% rise) of the slope on which the site was situated, *slope facing angle, physiographic location* (i.e., talus slope, first stream terrace, second stream terrace, and third stream terrace), and *proximity to water sources* (including distance from water and elevation above water). These variables were tabulated along with site type information. A one-sample Chi-square test (Siegel 1956:42-47) was applied to each of these variables (see Tables 1a-1f) so as to test and measure the association of site type and environmental features. As indicated in Table 1, five separate variables show significant associations: slope gradient (0-10%), physiographic setting (first stream terrace), altitude (500-1000 feet), distance from water (0-50 meters), and elevation above water (0-30 feet). From inspection of this table, it became apparent that the *three most important variables were slope gradient, distance from water and site altitude* variables. To investigate the relationships between the number of sites and slope gradient and the number of sites and distance from water, a second statistical test, Spearman's Rank Order Correlation Coefficient (Siegel 1956:202-213), was applied. The results of these tests (as seen in Tables 2a and 2b) demonstrate significant *inverse correlations* between *distance from water* and *slope gradient* and the *number of sites*. That is, as slope gradient increases, the number of sites decreases; nd as distance from water increase, the number of sites decreases. Although this information is not surprising to archeologists perhaps the reliability of a predictive model based on these variables is greatly increased. It should be noted at this point that these statistical tests could not have been validly applied to these data unless the data had been empirically acquired by statistical or probability sampling, such as was done throughout this survey.

Table 1b shows that there is a statistically significant relationship between site location and altitude. Table 1b shows that most sites, 86% (73 sites), were located between 500 and 100 feet

elevation. However, in order to get a more detailed picture of the site-elevation relationship, all sites found during the Caddo Unit sample survey were plotted by altitude.

This plot revealed two interesting patterns. The plot of sites by elevation showed there are two altitude ranges where most of the sites were located: 610 to 690 feet and 800 to 980 feet. This pattern is interesting from an archeological perspective because it seems to coincide with important prehistoric settlement patterns.

It was noted (Ray, Raab and Cochran 1976:Chapter 2) that most of the sites found during the Caddo Unit survey seem to be related to hunting or other short-term, specialized activities. Moreover, sites tend to fall into what was called *hunting camps or hunting stations*. The former are distinguished from the latter by the presence of a larger number of artifacts and greater variety of artifact types. Functionally, hunting camps are assumed to be base camps, or relatively more permanent sites from which smaller sites are occupied. The smaller sites are probably satellites of the larger sites and clustered around the larger sites.

Twelve hunting camps were discovered during the survey. Very interestingly, eight of the twelve hunting camps occur in the two altitude ranges. The important pattern here is the association of the large hunting camps with the two altitude ranges containing most of the sites. These data suggest that the hunting camps are the functional center of prehistoric settlement patterns composed of seasonally reoccupied base camps from which smaller satellite sites were occupied. This pattern indicates that the altitude ranges of 610 to 690 and 800 to 980 feet should be given especially close attention during any future archeological work in the area.

Predictive Site Location. Considering the environmental variables discussed in the preceding section, a tentative model of site prediciton can now be provided. The variables in question for stream valley sites of all sizes are slope gradient (0-10%), physiographic setting (first stream terrace), altitude 610-690 and 800-980 feet and distance from 0-50 meters. Based on the survey and analysis results, it is probable that when these variables are present, conditions are quite favorable for the presence of stream valley sites (which in the Caddo Planning Unit would more than likely be hunting camps or stations). It should be pointed out that slope facing direction proved to be relatively insignificant with respect to site location (as seen in Table 1). The question of whether site location has any significant association with this variable has been of interest to archeologists in the Ozark Mountains although no formal testing has been attempted

as yet. With respect to the data accumulated during the Caddo Unit survey, this does not seem to be a significant factor in site location. Statistical tests were not done for stone quarry-workshop sites since relatively few were located during the survey.

Based on the environmental data obtained, it appears that most sites in the Caddo Unit are located on mountain slopes or ridge tops above 1000 feet elevation. Generally, slope gradients and distance to water would be rather large. Statistical analysis was also not performed with respect to the data acquired concerning historical sites for basically the same reason as stated for quarry-workshop sites. Before significant findings could be obtained with regard to such sites, a specific research design considering the history and environment of the area should be prepared.

Overview of Results

Sampling in Woodland Environments. The sample survey strategy adopted for this project was modeled closely after that of the archeological sample survey of the White Mountain Planning Unit of the Apache-Sitgreaves National Forest, Arizona (Donaldson 1975). Nevertheless, there are several notable differences between the environmental settings of the two regions which placed constraints on the effectiveness of the sampling strategy of the present project. The most notable difference was the ground visibility factor. While the White Mountain survey dealt primarily with juniper-pinyon woodland and Ponderosa pine forest with relatively sparse, short-grass ground cover, the Caddo Unit survey was faced with mixed hardwood-pine forests having extensive ground cover on or in hillslopes, ridges, and small stream valleys. This naturally resulted in some modification of tactics, most notably the exposure of the ground surface with shovels at regular intervals along sample transects (Ray, Raab and Cochran 1976:Chapter 2). A similar type of technique has been demonstrated as effective in woodland environments in the northeast by Lovis (1976). A second factor which distinguished the present project from the White Mountain survey was the existence of numerous privately owned land parcels within the Caddo Planning Unit. This resulted in difficulty of locating and establishing the starting points of many of the transects. Also, some of the transects were interrupted by privately owned land, thereby causing time-consuming delays in the survey schedule and creating transects of variable length. Access across private property was often difficult and sometimes impossible to obtain. The rugged terrain characteristic of the Ouachita National Forest posed further limitations on the survey procedures. Roads

TABLE 1

CHI-SQUARE VALUES FOR
ENVIRONMENTAL VARIABLES

	Observed Frequency	Percentage of total	Expected Frequency
1a. Physiographic Setting			
Uplands Region (talus slope, ridge top, mountain slope)	10	12%	28.3
First stream terrace	56	66%	28.3
Second and third stream terraces	18	22%	28.3
Total	85	100%	85

X^2 = 40.7
df = 2
p< .001, significant association

	Observed Frequency	Percentage of total	Expected Frequency
1b. Altitude (ft.)			
500	7	8%	28.3
500-1000	73	86%	28.3
1000	5	6%	28.3
Total	85	100%	85

X^2 = 105.9
df = 2
p< .001, significant association

	Observed Frequency	Percentage of total	Expected Frequency
1c. Slope Gradient (% rise)			
0-10%	72	85%	28.3
11-20%	11	13%	28.3
20%	2	2%	28.3
Total	85	100%	85

X^2 = 102.6
df = 2
p< .001, significant association

TABLE 1, continued

	Observed Frequency	Percentage of total	Expected Frequency
1d. Slope Facing Angle			
North	9	10%	10.6
Northeast	7	8%	10.6
East	12	14%	10.6
Southeast	16	19%	10.6
South	11	13%	10.6
Southwest	16	19%	10.6
West	10	12%	10.6
Northwest	4	5%	10.6
Total	85	100%	85

$X^2 = 11.5$
df = 7
$.20 < p < .10$ (no significance)

	Observed Frequency	Percentage of total	Expected Frequency
1e. Elevation above Water (ft.)			
0-30 ft	63	74%	21.25
31-50	8	10%	21.25
51-100	7	8%	21.25
100	7	8%	21.25
Total	85	100%	85

$X^2 = 109.4$
df = 3
$p < .001$, significant association

	Observed Frequency	Percentage of total	Expected Frequency
1f. Distance from Water (meters)			
0-50	43	51%	21.25
51-150	16	19%	21.25
151-300	14	16%	21.25
300	12	14%	21.25
Total	85	100%	85

$X2 = 30$
df = 3
$p < .001$, significant association

TABLE 2

SPEARMAN'S RANK ORDER
CORRELATION COEFFICIENT

2a. Slope Gradient (% rise)

	Value	Rank
0-5	42	1
6-9	13	3
10-12	20	2
13-16	5	4
17-20	3	5
20	2	6

r_s = .943
.05< p < .01

2b. Distance from Water (meters)

	Value	Rank
0-25	26	1
26-50	17	2
51-75	6	4.5
76-100	6	4.4
101-150	4	8
151-200	6	4.5
201-250	4	8
251-300	3	10
301-350	2	11
351-400	6	4.5
400	4	8

r_s = .866 Corrected for ties
p< .01

with access to transects were often nonexistent. Survey crews sometimes had to walk several miles over difficult terrain to find transect starting points.

Another major constraint on the sampling strategy was the actual nature of the sites found within the Ouachita National Forest. Of all the sites located during the survey, none except historic sites contained ceramics. This is apparently because with the highlands of this region, we are more likely dealing with either preceramic cultures or ceramic-level cultures temporarily or seasonally inhabiting the area for exploitative purposes (e.g., chert or novaculite acquisition and hunting).

All sites located are either related to hunting or manufacture-procurement of raw materials. Such activities would indicate small expeditions or individuals or small groups (e.g., hunters and stone tool makers) frequently shifting their residence. In such cases, there would probably be little need of ceramics (which are more often found at larger, more permanent habitation sites). With respect to the lack of ceramics being a hindrance to statistical sampling, it should be noted that ceramic sites, more often being general habitation sites, are typically larger and have a greater density of artifacts.

It is to be expected, then, that sample survey in the woodlands of the eastern U.S. must be prepared to deal with several problems:

(1) difficulty in developing sampling designs because public and private land parcels are interspersed and of variable size;

(2) site visibility is severely reduced by vegetation cover, requiring some method of clearing the ground surface for observation and/or rapid subsurface testing;

(3) small, seasonally occupied sites may be difficult to see, as will isolated scatters of artifacts.

From our experience with the Caddo Unit survey we believe that problem 1 above can be alleviated with a sampling program oriented toward establishing correlations between environmental features and site types and locations. This type of sampling seems to be more effective in the woodland environment than statistical-geographic sampling in establishing predictive models.

Problems 2 and 3 above remain problematic, but some progress toward their solution seems afforded by systematic ground clearing along sample transects. The ground surface of sample transects of the Caddo Unit survey was examined at 20 m intervals with shovels to reveal surface sites. This technique was successful in locating (Ray, Raab and Cochran 1976:11-12) sites, including isolated artifacts. Similar results have also been obtained with garden rakes elsewhere (Brooks 1976).

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LESSONS FROM THE WHITE MOUNTAIN PLANNING UNIT: A SMALL-SAMPLE SURVEY DESIGN FOR LARGE AREAS

By Bruce R. Donaldson

Introduction

Archeological research confronts its practitioners with a series of challenges. At the most general level such challenges are couched in terms of who, when, where, and even perhaps why and how questions. For those engaged in "applied" research--cultural resource management or CRM--additional challenges are presented; the archeologist is accountable to the contracting agent for the expenditure of funds, for timely performance, for providing required information--in short, for the CRM practitioner there exist managerial challenges as well. However, in only a limited sense is the last word in CRM "management," for the archeologist does remain accountable to the expectations of professional standards. The concept of professional expectations is what governs "pure" research and it should also apply to contract studies because contracts, and Federal law and policy (which often structure CRM goals), usually provide only broad, minimal guidelines for the archeologist.

As more archeologists become more involved with contract projects, there is an increasing danger that the intellectual challenges become overlooked amid the welter of managerial concerns (King 1977). This need not be the case. It is a central theme of the present collection of papers that both managerial and intellectual needs may be served simultaneously, that the two somtimes-divergent sets of challenges need not be considered mutually exclusive.

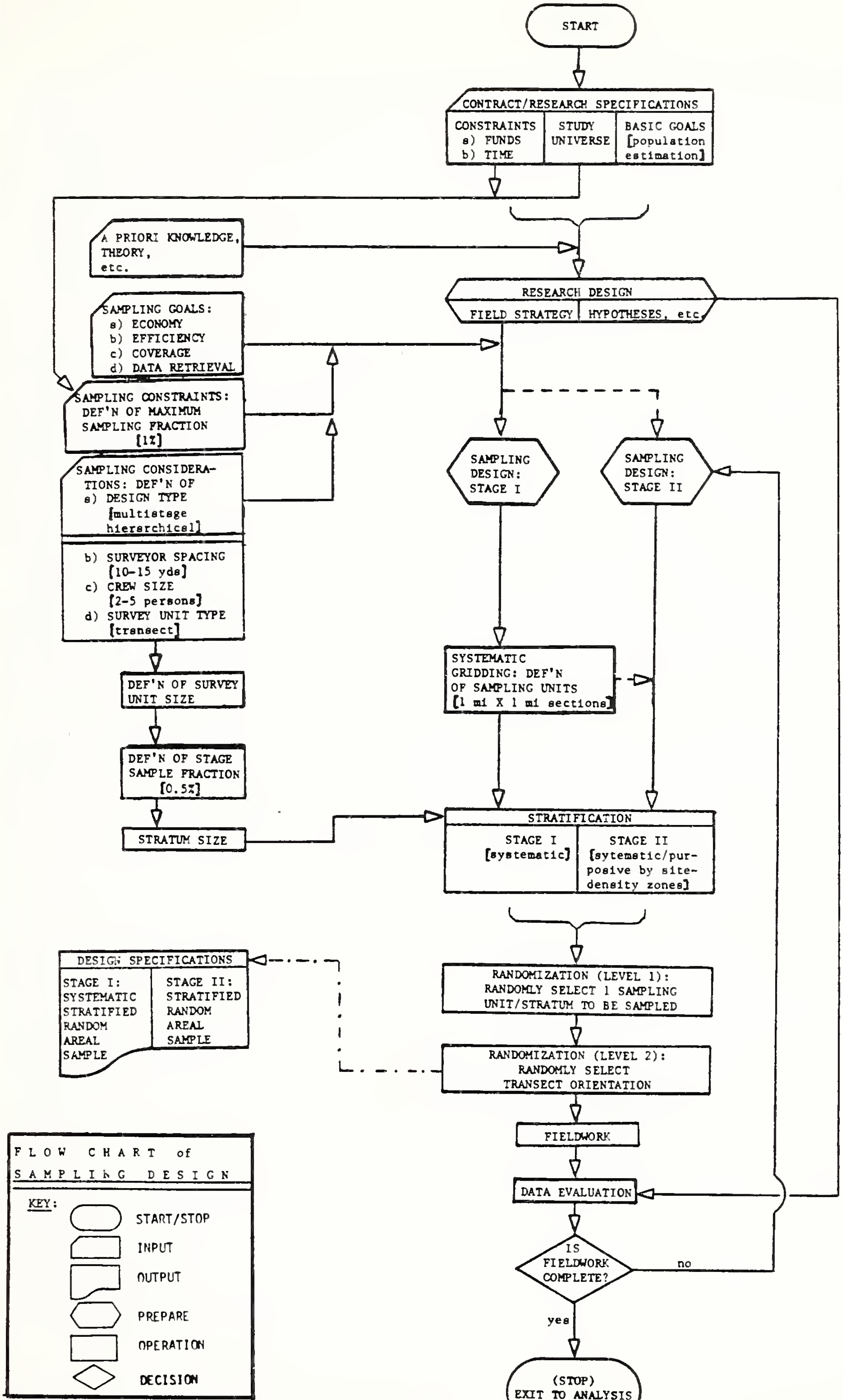
For my own part, I will discuss a number of issues related to regional sampling designs, and will attempt to show how the discussion of these issues is germane to managerial concerns and to the development of archeological methods as well. The discussion pertains to a modification and improvement of the sampling design used in a survey and assessment of cultural resources undertaken on the White Mountain Planning Unit, Apache-Sitgreaves National Forest, Arizona; I will not present the original design--which has been reported elsewhere (Donaldson 1975)--for that sampling scheme has some inherent problems when viewed in retrospect. The original design represents a specific response to a challenge presented by the Forest Service: Initate an inventory of the cultural resources on a given tract in such a manner that population estimates of

the kinds, density and distribution of those resources may be provided; do this with given constraints on the area involved and on the amounts of time and funds that can be expended. This paper represents a response to a different challenge: How might the original design be improved? Hence, as a retrospective assessment, the following discussion details some of the lessons learned from the study of the White Mountain Planning Unit.

Before proceeding, however, a few comments are in order. The sampling design was constructed for a particular area in the southwestern U.S., and the discussion involves some implicit assumptions which must be understood within such a context. Furthermore, I will not discuss all of the decisions that must be made in formulating a design, rather I have chosen to speak to certain issues which I feel to be salient to the design of a sampling program; some attempt has been made, nevertheless, to approach these issues in a logical order; where this has not been feasible, the reader has recourse to a design flowchart (see illustration) which provide a schematic framework for each topic discussed.

Research Design

The undertaking of a CRM project should demand the explication of a well-conceived and -considered design of research (Grady 1977; Thoms and Mayer-Oakes 1977). Not only will this practice meet with professional expectations (see Fritz and Plog 1970; Watson 1973), but will enable contract archeologists to meet with a challenge uniquely their own, i.e., the assessment and determination of resource significance. The framework for assessing significance transcends more specification of resource kinds, densities and distributions; it is found within the structure of an overarching research design aimed at gaining a full-as-possible understanding of a region's prehistory. The regional scope is necessary because significance requires a spatial context which encompasses more than the physical boundaries of the cultural resource itself (see, e.g., Dekin, et al. 1977). Only within such a framework can the archeologist adequately assess the significance of sites; "only in this framework can the archeologist adequately define the full impact of a project on cultural resources, or provide optimum recovery of information from threatened resources" (Anderson 1974:113; Donaldson 1975; King 1977; Schiffer and House 1977).


START
CONTRACT/RESEARCH SPECIFICATIONS
CONSTRAINTS
a) FUNDS
b) TIME
STUDY UNIVERSE
BASIC GOALS [population estimation]
A PRIORI KNOWLEDGE, THEORY, etc.
RESEARCH DESIGN
FIELD STRATEGY
HYPOTHESES, etc.
SAMPLING GOALS:
a) ECONOMY
b) EFFICIENCY
c) COVERAGE
d) DATA RETRIEVAL
SAMPLING CONSTRAINTS: DEF'N OF MAXIMUM SAMPLING FRACTION [1%]
SAMPLING CONSIDERATIONS: DEF'N OF
a) DESIGN TYPE [multistage hierarchical]
b) SURVEYOR SPACING [10-15 yds]
c) CREW SIZE [2-5 persons]
d) SURVEY UNIT TYPE [transect]
DEF'N OF SURVEY UNIT SIZE
DEF'N OF STAGE SAMPLE FRACTION [0.5%]
STRATUM SIZE
SAMPLING DESIGN: STAGE I
SAMPLING DESIGN: STAGE II
SYSTEMATIC GRIDDING: DEF'N OF SAMPLING UNITS [1 mi X 1 mi sections]
STRATIFICATION
STAGE I [systematic]
STAGE II [sytematic/purposive by site-density zones]
DESIGN SPECIFICATIONS
STAGE I: SYSTEMATIC STRATIFIED RANDOM AREAL SAMPLE
STAGE II: STRATIFIED RANDOM AREAL SAMPLE
RANDOMIZATION (LEVEL 1): RANDOMLY SELECT 1 SAMPLING UNIT/STRATUM TO BE SAMPLED
RANDOMIZATION (LEVEL 2): RANDOMLY SELECT TRANSECT ORIENTATION
FIELDWORK
DATA EVALUATION
IS FIELDWORK COMPLETE?
no
yes
(STOP) EXIT TO ANALYSIS
FLOW CHART of SAMPLING DESIGN
KEY:
START/STOP
INPUT
OUTPUT
PREPARE
OPERATION
DECISION

If the research design, in general, specifies what data need be collected, the sampling design specifies how those data will be gathered. The probabilistic sampling scheme is the key component in any design of research, for rarely if ever do archeologists have the opportunity to examine all the data in a given universe; thus only through the application of an explicit sampling design can statements be confidently made about the nature of that universe.

Sampling Design

Since National Forest land-use planners are primarily interested in the where kinds of question, the archeologist's main concern should be with developing some predictive model of site location, a model useful for planning purposes. Such models most often rely heavily on the control of environmental variables (see Raab, and Schneider and Franz in this volume). While I do not disagree with this approach (see below), from a managerial stance it would seem that it is as important to know where sites are not located; hence, as a primary goal of the sampling scheme I would elect to ensure that the study universe has even coverage, at least at the preliminary stage of survey. How the emphasis on coverage affects design formulation will be seen below, but first it is necessary to provide a general overview of the design's characteristics.

The sampling scheme is hierarchical in nature, or, as others might term it, a nested or compound design. In order to generate a model predictive of site location, the archeologist must control to some degree the factors influencing the location decisions that were made in the past; the nature of many of these factors is environmental (see F. Plog 1968; Struever 1968; Gummerman 1970). In terms of relative magnitude, however, different variables one might wish to consider are measured at different scales, and "relationships among variables measured at one scale are not necessarily established and relevant at a different scale" (Dekin, et al. 1977:16). One solution to this problem is found in the hierarchical sampling design. Preliminary levels may be used to control for relatively large-scale variables, while subsequent levels are useful for encompassing smaller-scale measures. A hierarchical scheme designed for low-intensity sampling of large areas allows generalization from smaller-scale units to larger-scale units and from those to the study universe.

Of the two levels in this design, the first selects units to be sampled in what is characterized as a systematically stratified random areal sample; the second level is used, in effect, to sample that sample. Although as presented, the first level's major purpose is to provide for even coverage, but control of large-scale environmental factors (such as plant community, soil

zone, drainage) are also encompassed; at the second level, smaller-scale environmental variation and, when sites are located, site-specific characteristics are brought under control.

First-Level Design

Universe. In regard to the sampling universe, planning unit studies are designed by the Forest Service to aid in the formulation of sound management policy regarding the development of economic and natural, as well as cultural, resources on public land. Therefore study universes are defined with renewable resource considerations uppermost in mind (Wildesen, this volume, notes that cultural resources make up only one of seventeen categorical concerns), and they are likely to be arbitrarily defined with respect to the distribution of the non-renewable cultural resources. On the Apache-Sitgreaves such universes are on the order of 200-300 square miles. Tracts of this size present fewer problems of research design and data interpretation than do, say linear right-of-way studies, but the arbitrary boundaries may still tax the archeologist's ability, ingenuity, and patience. In any case, the universe is simply a "given" for the archeologist, a constraint--or challenge, in a sense--under which the investigator must operate.

Sampling unit. The selection of the mile-square section as the basic sampling unit is made for a number of reasons. As the basic unit of the USGS Township-Range System, the section systematically grids a study universe in a manner which is completely arbitrary with respect to prehistoric cultural phenomena, hence provides a sound and acceptable basis for structuring a probability sample. Since on the Apache-Sitgreaves, land-survey crews have located and marked most section-corners and many quarter-corners (that is, midpoints along the sides of the section), sections have "built-in" landmarks, each of which unambiguously provides a datum from which survey units may be precisely defined. Corners are, in most cases, at least as easy to locate as landmarks derived from topographical maps or aerial photos; survey crews know where they are on the ground, and inventoried site locations may be accurately plotted. Thus there are pragmatic reasons for use of the section as the sampling unit as well as theoretic.

Strata. Groups of sections may be used as arbitrary units of stratification. Systematic stratification is advocated, the justification provided by the need for and desirability of even coverage. The size of these units depends upon the sampling intensity chosen by the archeologist, which, as will be seen, depends upon the convergence of other decisions related to size

of the survey unit and of the survey crew. In any event, the size of the stratum is such that the sampling intensity will require that only one survey unit per stratum need be selected.

Given that a stratum consists of a number of sampling units, there exist different ways in which the same number of sampling units may be combined to creatively shaped strata. The strata should be as compact as possible, the best alternative being a stratum configuration for which the sum of the lengths of the stratum's sides are at a minimum (that is, strata should be square or nearly square rectangles rather than relatively long, narrow rectangles). The rationale behind any stratification procedure derives from the principle that, "to the degree that the strata are homogeneous with respect to the variables being studied, we can improve the efficiency of the design" (Black 1972:516), and the above suggestions on stratum compactness and minimal size would aid in the achievement of such an end.

Having systematically stratified the universe, then, the final step in the first level of the design is to select randomly one section from each stratum for sampling. With this accomplished, the preliminary stage of the design procedure is complete.

Second-Level Design

The purpose of the second level of the hierarchical design is to sample the sample selected at the first level; the size of the first-level unit (one square mile) precludes complete survey in a situation where the archeologist is concerned only with a low-intensity, representative sample. As noted above, the results of the second-level sample may be generalized as adequately describing the first-level units, and these latter, taken together, describe the universe; again, allowing for problems of resolution, this allows for control of variables measured at varying scales. In this manner are archeologists able to sample a large area at a low intensity, yet maintain efficiency, economy, and confidence in the results derived.

Survey unit. It is useful at this point to distinguish between the sampling unit--defined as the basic unit of the first-level design--and the survey unit which is a geographical unit surveyed in its entirety. (Apologies are owed to purists for coining a new term, but I think "survey unit" conveys the difference from "first-level sampling unit" more readily than the phrase "second-level sampling unit" which is what the survey unit actually is.) The two kinds of survey units deemed appropriate for large-area reconnaissance are rectangular quadrats and relatively long, narrow transects. Each of these is more suitable for particular kinds of

data collection; for instance, transects yield better information as to the content of the cultural record, while quadrants are better suited for unveiling the structure--or intersite relationships--of that record (F. Plog 1972; Matson and Lipe 1975). Planning-unit survey, as stated, is reconnaissance performed to obtain population estimates of cultural resources, and it is generally accepted that such surveys are more efficiently and economically undertaken through use of transects (F. Plog and Hill 1971; Judge, et al. 1975; S. Plog 1976). Moreover, since one goal is to gain knowledge of smaller-scale variability in environmental factors, the transect is the more informative survey unit (Daubenmire 1968). Therefore, for reasons of economy, efficiency and information retrieval, the transect is advocated as the better survey unit for land-use planning surveys.

Placement of the transect/survey-unit within the sampling unit is best undertaken with consideration of the positive attributes of the sample unit noted previously, viz., the presence of permanent landmarks in the form of section- and quarter-corners. Transects may be placed between opposite quarter-corners on a "perpendicular" east-west or north-south axis, or between opposite section-corners on a "diagnonal" northwest-southeast or northeast-southwest axis (see Figure 1). In order to introduce another element of randomness, it is suggested that the orientation of each survey unit be chosen randomly from among the four alternatives (differential orientation allows for control of variable/site location within the general trend of, say, landforms by variously cross-cutting the trend). Since the "perpendicular" transects (one mile in length) are shorter than the "diagonal" (1.414... miles in length), it is also recommended that only the data from one-half mile of either side of the "diagnonal" transect midpoint be used for statistical purposes; this procedure ensures that all sample-unit population estimates are based on unit sample fractions of the same size (see Figure 1).

With the placement of survey units done, the generalized sampling design is completed. The basic components of this scheme are seen to include randomly oriented survey units located with randomly selected sampling units each of which lies within a stratum of a systematically stratified universe. The complexity of the design's justification should not detract from the observations that (1) even coverage of the universe is assured through systematic stratification, yet (2) the validity of the sample is not compromised because of the introduction of a random element at each level of the design hierarchy; (3) use of transect survey units which are anchored to permanent, on-the-ground landmarks heightens the economy, efficiency and information-retrieval characteristics of

FIGURE 1: Transect Placement Alternatives

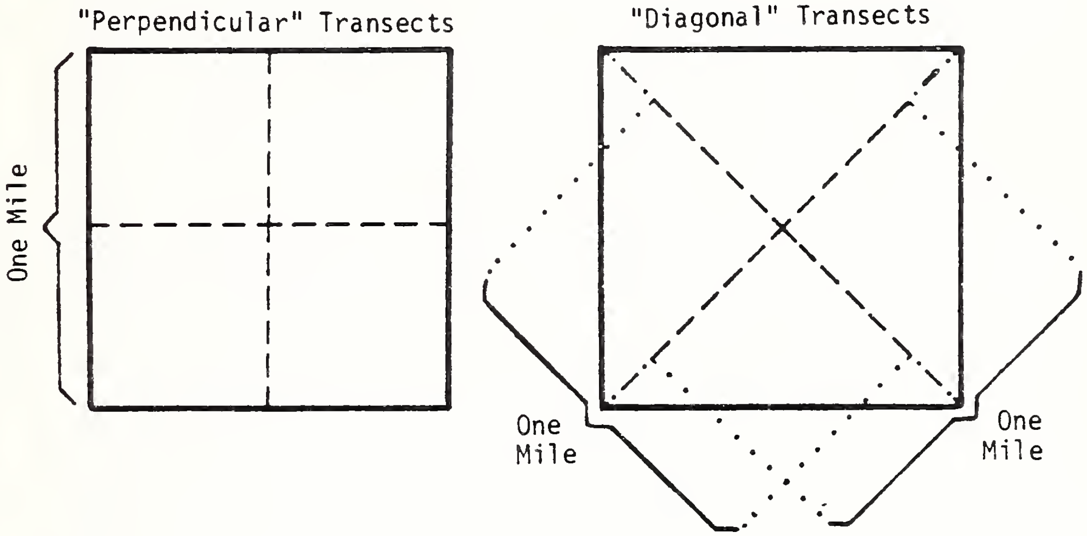
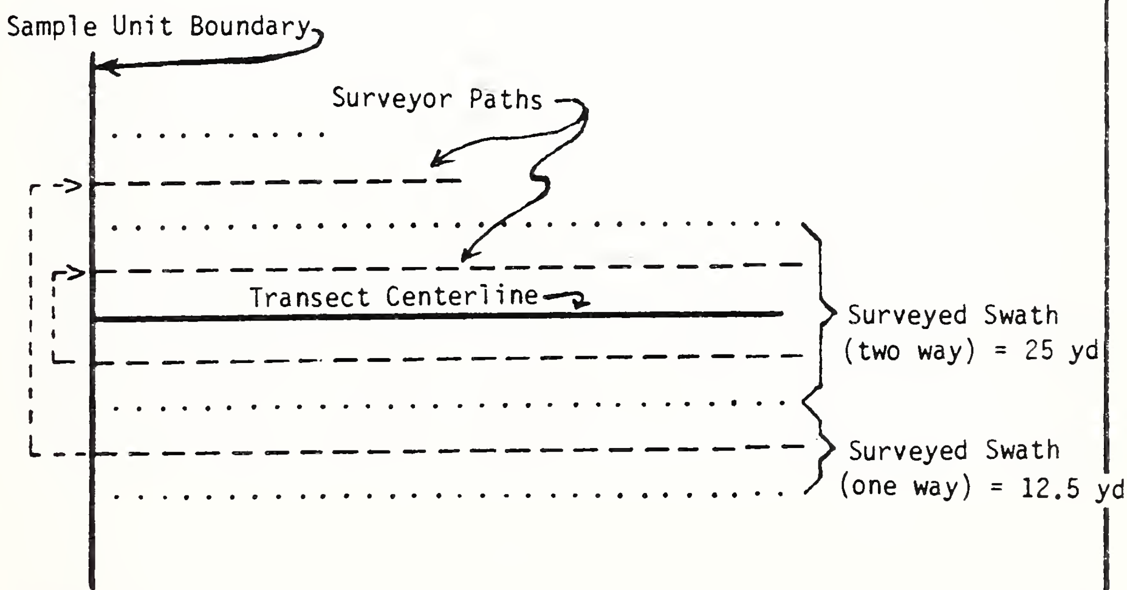


FIGURE 2: Survey Tactics



the design; and (4) the product of the low-intensity design can be used with confidence by land-use planners. Our experience with similar designs has shown that information on at least the densities and distributions of sites is adequately retrieved and that this data may be used to generate an accurate predictive model of site incidence and location within the universe.

Operational Considerations & Sampling Intensities

To this point I have avoided discussion of sampling intensity or sample fraction. The reasons for this are found in factors which are largely exogenous to the sampling design itself, factors which could be considered under the rubric of Field Tactics.

One pragmatic factor is the matter of crew size. The upper bound, in our experience with woodland and forest survey in the Southwest, would be on four- or five-person crews; a crew larger than this is difficult to coordinate and control in the field. On the other hand, crews of two or three are optimally efficient in terms of performance of data collection tasks and are also economical in that a survey team of a given size may be divided into a maximal number of crews and dispersed over the study area for more rapid completion of a given number of survey units. Whatever the crew-size selected, all crews must be of the same size in order that unit sample fractions be equal.

The spacing between crew members is also an important factor, and one that seems to have received little theoretical consideration. Indeed, mention is rarely made of this factor and the omission of such statements from any survey report is not a trivial matter. Before one can place confidence in a sample, one must know that it is reliable at least to the extent that, with exception due to observer error, <u>every</u> site within a survey unit has been found; otherwise the door has been opened for the admission of unknown, uncontrollable bias. In the Southwest, for example, too wide spacing of surveyors would fail to locate a disproportionate share of those sites lacking remnants of standing architecture.

This problem, however, may be approached empirically. "The critical factor in survey is the minimum dimension of the sites, since it cannot always be assumed that a given transect will intersect the longest dimension of a site" (Lovis 1976:370). Assuming the worst possible situation, i.e., that any transect will intersect the shortest dimension of a site, then the <u>median minimum dimension</u> is the strategic statistic that must be considered.

TABLE I: SUMMARY OF SITE DIMENSIONS, WHITE MOUNTAIN PLANNING UNIT (n = 181)

	Minimum	Maximum
Mean	20.79 yd	32.33 yd
S. D.	17.58	26.60
Median	16.67	23.33
Range	1 - 100	2 - 145

Using a minimum definition for a site as a locus containing five or more artifacts per square yard, crews under my supervision, spaced at 10-15 yard intervals, have inventoried some 181 sites on the White Mountain Planning Unit (this sample includes a large number of sites surveyed subsequent to the contract work for an unrealted project). For the sample (see Table I), the median minimum dimension is 16.67 yards, indicating that surveyors spaced at that distance would walk over at least 50% of all sites within the survey unit. Given that surveyors visually inspect territory on either side of the survey path, and that surficial features and artifacts are generally visible up to ten yards distant, then it may be stated that a 10-15 yard surveyor spacing is near optimal for complete discovery within the surveyed area.

At this point I will pull together a number of issues already discussed and turn attention to the sample fraction or level of sampling intensity. Given that (1) for convenience of calculation surveyor spacing is 12.5 yards, (2) a crew will survey a transect by walking its length, turning 180^{0} and returning on an adjacent course that parallels the original swath, and (3) a transect is one mile in length, then the only other variables necessay to compute the sample fraction are transect width and stratum size. Transect width is a direct function of crew size in that for every surveyor, a 25-yard swath will be surveyed (see Figure 2). Recognizing that different archeologists will choose to use different crew-sizes as well as different sizes of strata depending upon the needs and constraints of a particular project, Table II provides sample fractions for various combinations of crew and stratum sizes; these fractions are calcualted down to the level of .0047 or about one-half of one percent.

TABLE II: SAMPLING INTENSITIES

Stratum Size (mi^2)	Crew Size/Transect Width (yds) 2/50	3/75	4/100	5/125
1	.0284	.0426	.0568	.0710
2	.0142	.0213	.0284	.0355
3	.0095	.0142	.0189	.0237
4	.0071	.0107	.0142	.0178
5	.0057	.0085	.0114	.0142
6	.0047	.0071	.0095	.0118
7		.0060	.0081	.0101
8		.0053	.0071	.0089
9		.0047	.0063	.0079
10			.0057	.0071
11			.0052	.0065
12			.0047	.0059
13				.0055
14				.0051
15				.0047

Our experience has shown that a territorial sample of 1% is usually sufficient to estimate reliably such population parameters as are generally called for in land-use planning studies (Donaldson 1975; F. Plog 1976; see also Read 1976 for a theoretical justification of low-intensity archeological sample). Experience has also shown that a 0.5% sample will, on a preliminary basis, yield information on the general nature of the target population. In keeping with the basic sampling goals of economy, efficiency, and optimum

information retrieval, use of multistage sampling technique is advocated (NB: This is to be distinguished from the multilevel hierarchical design; see Redman 1973). By using the 0.5% intensity level for each stage of investigation, and restratifying the universe after each stage is completed, the sampling goals are better realized.

One criterion for second-stage stratification which would be useful in meeting managerial and sampling goals is that of site density. Preliminary results from a first-stage, 0.5% intensity survey should usually be adequate for this task. The number of sites per transect (rarely exceeding four in our experience) can be used to score surveyed sample units. These scores would then be used as data points, each being plotted in the center of this respective sampling unit on a map of the study area. Using these data points as density indicators, one would plot site-density contours by connecting lines between units with equal scores; some interpolation may be necessary to define the location of intermediate-ranked contours but this requires no more equipment than a scaled straightedge and a scratchpad or pocket calculator. (In essence, this is no more than a manually performed SYMAP; the task is not at all onerous: a relatively large universe stratified into relatively small strata would result in only fifty discrete data points; the calculation is: 300 mi^2 universe/6 mi^2 per stratum = 50 strata x 1 data point per structum = 50 data points.) The result of this exercise would be a universe stratified into differential density zones which would then be used to restratify the universe and to provide a basis for disproportionate sampling within each zone. Specific decisions on how this would be accomplished would be dependent on the particular situation; it will suffice to note in this regard that one of the inherent attributes of a multistage design is its flexibility.

The general justification for including the multistage concept in this manner is found in both management and sampling goals. Sampling high-density areas at a relatively high intensity, and low-density zones at low intensity, would generally mean that more sites are located per unit sampled during the second-stage survey; this would lead to increases in data recovery and in efficiency and economy for a given level of effort. More sites located means more information on the kinds and variability in site-types, and the use of such a scheme would also lead to a more precise estimation of site-density gradients and of site distribution over space.

Conclusions

The bottom line on most archeological research, whether contract or otherwise, is how much one learned for the time, funds, and effort expended. The key to successful research is in the planning,

for the results of operations and analyses are ultimately dependent on this. In summary, research designs can be conceived of as planning frameworks in that they detail the kinds of information desired. Research designs are essential for explicitly defining direction and goals, and they provide the basis for evaluating the results of field work.

The design of a sampling strategy is a major component of the research design. The application of sampling techniques requires the recognition of certain goals appropriate to research constraints and particular to sampling theory and methodology itself. The generalized design presented above has made those goals explicit and is specifically geared to meeting them. These research, sampling, as well as managerial goals represent the challenges that contract archeologists face. I have attemped to demonstrate that, from a particular land-use planning contract, we have been able to benefit from the opportunity to experiment with sampling methods and in areas of theory and application.

In closing, I would make the point that cultural resource management needs and the generally increased accountability will require further refinement of archeological method and technique, as well as more explicit treatment of these areas in contract reportage. In this manner will we learn our lessons, making us better able to meet the challenges presented by our professional responsibilities.

Acknowledgements

The particular sampling design and contigent issues discussed above represent an outgrowth of similar designs developed, applied and modified at various times by Dr. Dwight W. Read, Dr. Fred Plog, and Dr. Stephen Plog; the justifications underlying various decisions as presented here are my own and do not necessarily correspond to those that might be used by the above named. Dr. Charles L. Redman, in earlier discussions of some of these issues, has given me the benefit of his experience and critical insight, forcing me to clarify my thinking on several points. Dr. Albert A. Dekin, Jr., Edwin Hession, and Judith Rasson read a previous draft of this paper and offered a number of helpful editorial suggestions, and Pandora Snethkamp generously assisted in the preparation of the design flowchart. To all of these individuals I owe a debt of gratitude, but I must reserve all responsibility for the content of the paper for myself.

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The Research Potential of Multiple-Use Studies

By Fred Plog and Jon Scott Wood

Introduction

The subject of this paper is the research potential of multiple-use studies, specifically those undertaken for the U. S. Forest Service and based on extremely small fractions. Initially, one might question the necessity of addressing such an issue. These studies involve the collection of archeological data, often in areas where limited data are currently available. Moreover, in the specific case of the surveys we and other working with us have undertaken on the Apache-Sitgreaves National Forest, there are minimal differences between the data collection strategies used in multiple-use and "pure research" studies.

The problems that lead to doubts about such studies concern (a) the small sample fractions that are characteristic of both our multiple-use and nonmultiple-use work and (b) potential differences in the topics that are addressed in analyses written for each. We shall consider (a) the nature of the data base generated by such studies; (b) the representativeness of that data base; and (c) the pertinence of analyses undertaken largely for multiple use planning to understanding local culture history and testing hypotheses concerning cultural processes. Our argument is that multiple-use studies result in the generation of data adequate to the understanding of some, although certainly not all, problems of culture history and cultural process, and that the difference between the analyses undertaken for such studies and those undertaken for the purpose of "pure" regional research can, and should be, minimal.

The Nature of the Data Base

The Apache-Sitgreaves National Forest covers an area of about 3000 square miles. Our research to date has been conducted on the segment of the Forest between Chevelon Creek on the west and the general vicinity of Nutrioso Arizona on the east, and area of 1340 square miles. In a variety of projects directed by a number of individuals, a total of 22.1 square miles have been surveyed, 1.6% of the total area.

The strategy employed in the survey has been multistage. Stage one has involved the selection of random stratified transects at a density of one for each six sections in the area study. Stage two has been transect survey with stratification based on the relative density of sites as defined in the stage one research. Stage

three has involved surveying block or contiguous areas ranging from ¼ to 3 square miles in area. These blocks have been located on exclusively judgmental criteria. Of the area surveyed to date, 9.1 square miles (40%) have been in sample transects and 13.0 square miles (60%) have been contiguous judgmental blocks. This effort has resulted in the generation of records on about 1000 archoelogical sites on the Forest. The adequacy of this data base can be evaluated with respect to both (a) current suggestions concerning desirable sample size and (b) generalizations about the prehistory of the area that have been made on the basis of data existing prior to our surveys.

There are many circumstances in which it is necessary for archeologists to generalize concerning the prehistory of regions several hundreds, thousand, or tens of thousands of square miles in area. Most archeologists now recognize that such generalizations are invariably based on samples. There has been much discussion concerning the percentage of such an area (sample fraction) that should be surveyed before such generalizations are made. Estimates range as high as fifty percent and are only infrequently below twenty percent.

The implications of such a suggestion in the case of the Apache-Sitgreaves Forest are clear. To the extent that one can project straightforwardly from existing data, a survey of 20% of the Forest would result in information on about 12,500 sites; a survey of 50% in information on 31,250 sites. I suggest that there is no analytical strategy currently in existence in archeology that is capable of handling such massive quantities of information. Granting the systematic bias of the data we have collected, it is not unlikely that figures roughly half of those stated are more likely. Even so, the notion that information on 6,000 sites (a 20% sample) is required to generalize about the prehistory of the area is patently absurd.

At the other extreme, generalizations about the prehistory of this area have been made for several decades. These generalizations are based on survey and excavation records of only about 100 sites. No systematic or stateable strategy was used in collecting these data. In short, the data are limited in quantity and biases exist but cannot be described.

In summary, a one percent sample of the Forest has resulted in (a) more data than have been considered adequate for generalizations in the past and (b) far fewer data than the unmanageable quantities that would result if some of the more extravagant claims concerning sampling fractions were followed. Of course, the required sample fraction will vary with the problem under consideration. But the time has clearly arrived for recognizing the adequacy of particular sample fractions must be empirically calculated and for beginning

to make realistic statements about sample fractions rather than uninformed statements--guesses more accurately--that if followed will result in the collection of more site data than any archeologist is currently capable of analyzing.

Representativeness of the Data

"Representative" is a relative term. What specific sampling fractions and data collection strategies will and will not permit in the way of inference is relative to the specific inference in question. Clearly, the data available for the Apache-Sitgreaves as a result of the multiple use and regional samples that have been done there must be presumed more representative than the vertable handful of sites previously recorded. But, much research remains to be done for this and other areas to establish the desirability of particular sample sizes and fractions for data that will be representative in relation to particular problems.

We will consider here the question of representativeness in relation to the density of sites in two survey areas. In past years, sample data have been collected for the Purcell-Larson, North Forest, Saffel Canyon, South Fork and Indian Tank Hill areas. Subusequently intensive surveys were undertaken in contiguous blocks there. Table One shows the relations between the two areas based on these studies. Clearly, these data alone do not establish the case for representativeness; there is no way of doing so. But, at least for purposes of comparing and contrasting relative site densities, the approach seems a useful one.

TABLE ONE: A Comparison of Transect and Block Survey Data

Survey Unit	Size (mi^2)	Observed Site Density (mi^2)	Predicted Site Density[1] (mi^2)	Ratio
Purcell-Larson	3.0	39	51	1.3
North Forest	1.0	27	39	1.4
Saffel	0.25	28	28	1.0
South Fork	0.25	20	21	1.1
Indian Tank Hill	0.25	20	21	1.1

[1] based on the average density of the five closest transects

In the case of the Saffel, South Fork, and Indian Tank Hill units, the case for representativeness is clear. Predicted density for the Purcell-Larson and North Forest units is higher than that observed. The error factor (ratio) is close, however, so that estimates of relative density could be based on the figure. The data indicate that comparisons of the two units in the Chevelon drainage (Purcell-Larson, North Forest) with those near Springerville (South Fork, Indian Tank Hill, Saffel) would be highly problematic. The difference in accuracy of the predicted densities may reflect cultural factors. It more probably reflects survey techniques, however, since the transects used in Chevelon were larger. (A number of investigators have now observed the tendency for transects to result in overestimates of site densities proportional to their perimeter, an "edge effect.") It is essential to recognize, however, that given an analysis such as this one, it is a very simple matter to control for the bias, whatever the source, thereby alleviating much of the representativeness problem.

It is after all frequently the case that archeologists deal with unrepresentative data. Representativeness is not something that simply exists or doesn't exist, it is a continuum--any set of data is more or less representative for any given problem. One establishes the representativeness by identifying the biases in a set of data and either controlling for them or eliminating them in some fashion. Controlling for biases is far simpler with sample survey data than data collected from a contiguous area using a completely judgmental approach. We know for example that in the central part of the Forest, transects adjacent to private land average 1.4 sites; those away from it 1.0. In the eastern part of the Forest, the relationship is even stronger. Transects adjacent to private land average 0.5 sites; those away from private land 0.2. Once identified, this bias can be controlled for. Whether it would be identified in a nonsample based approach to surveying is very difficult to say.

The Relevance of Multiple-use Studies

Our final, and most important topic, is the relevance of data collected for mulutiple-use planning to archeological research. In some respects, it is surprising that such an issue should even arise. However, the distinction between "management information" and "research" is becoming increasingly entrenched in the literature of cultural resource management and it is this distinction that creates or at least raises the issue. We do not believe that there is a difference between management information and research. Management recommendations that are not based on substantial analyses are merely guesses. Management recommendations that are not made in the context of significant problems of local prehistory and cultural process are incomplete. The work required to make management recommendations informed and complete is called archeological research.

This past summer several students working with us completed a survey of the Little Colorado Planning Unit. Subusequently, we submitted to the Forest Service a 400 page report. About 10% of this report straightforwardly addresses management problems. The remaining 90% summarizes the research on which our recommendations are based and/or explores methodologies for improving the quality of that information. The results of several of these papers indicate the very close connections that can and should exist between management information and prehistoric research.

The contract required that a predictive model of site locations be developed for the planning unit. This model was developed by Wood. He was able to demonstrate that roughly 90% of the locational variability could be accounted for using four variables: sites are on surfaces with elevations of 2200 to 2500 meters; they are within 1 km. of the pinyon-juniper woodland; within 1 km. of Nutrioso Loam or another of the rigidly classified arable soils; and finally, they are located on low ridges. An even stronger relationship is obtained when scaled measures of (1) resource availability and (2) extent of prehistoric utilization are concerned.

There are numerous implications of this study for pure research. First, the articulation of the study with the research design of the Southwestern Anthropological Research Group is obvious. And, it indicates, as SARG members are learning in other study areas, that soil characteristics prove to be the most powerful predictors of locational variation. It is a more powerful predictive model than has been developed by any SARG member to date. Much of this increased power seems to drive from the use of scaled measures of resource availability and extent of utilization rather than simple counts of sites. It may be that the SARG focus on number of sites as a topic variable is a major problem with that effort, that too many independent variables affect this dependent one and that more synthetic utilization indices will be necessary if the effort is to succeed. Thus, the study has identified some fruitful directions that SARG may wish to explore. Finally, the model developed for the Little Colorado Planning Unit differs from that developed for other units on the Forest. To the extent that modern environmental variables can be correlated with prehistoric ones and meaningful systemic connections identified, much research can be done on what are apparently quite different local adaptive systems on different parts of the Forest.

A second task required by the contract was the generation of sensitivity maps. This task was done by Jeff Hantman using the SYMAP program. Hantman applied many of the options to the Planning Unit generating maps with different characteristics that showed quite different patterns. The interpretability of some of these is low. However, one map accurately reflects the distribution

of the discontinous clusters of high site density on the unit and a second reflects those areas in which other such clusters are likely to be found. At this level, the product is management information. However, the generation of a variety of different computer maps for the same set of survey data will also provide archeologists working with this technique with a good case study on the strengths and weaknesses of the various SYMAP options.

A third task was the evaluation of the extent of impacts on archeological sites on the Planning Unit. This study was done by Julie Francis and Kent Lightfoot. They generated the typical records on the extent of destruction of sites as indicated by evidence of pothunting. Then they attempted to evaluate the extent of which the integrity of the archeological evidence on site surfaces had been affected by casual collecting of artifacts from the site. Ceramic and chipped stone densities, and the proportions of different kinds of artifacts were examined. Independent and intervening variables included proximity to roads, ease of access, visibility of the site, and site type. Francis and Lighfoot were able to demonstrate that between 30 and 60 percent of the variation in some aspects of artifactual evidence on these sites could be explained by proximity to roads and/or proximity plus visibility. Most of us are aware of the difficulty that archeologists have encountered in identifying cultural variables that account for this high a percentage of the variation.

In the course of their analysis, Francis and Lightfoot were able to give a very precise meaning to the term "indirect impact." In the case of ceramic variables, sites within 400 meters of roads are different from those over 400 meters from roads. In the case of chipped stone, the critical boundary is about 200 meters.

The research implications of this effort are substantial. First, it provides good information on the behavior of casual collectors; one of the more important causes of post-depositional transformations that affect the inforamtion that can be recoverd from sites. Second, it suggests that archeologists must be very careful about analyzing a set of data unless they control for the effects of collecting. Fortunately, casual collecting seemed to have only a limited effect on the ratio of different kinds of artifacts recovered from the site. But, there were other powerful effects on artifactual variation. Much additional research must be done before this phenomenon is understood. But, unless it is understood archeologists risk attempting to identify prehistoric causes for aspects of avaibility in survey data that are in a fundamental sense the product of recent activity.

A final case is the opposite of the preceding. Roberta Jewett and Jeff Hantman carried out analyses of survey data from the Forest using the locational criteria that Plog has argued are sensitive social organizational indicators: density, evenness, hierarchy, agglomeration, etc. (Plog, 1974). The contract did not call for this activity. We undertook it for two reasons. First, all of the Planning Units on the northern part of the Forest will soon have been done. At that point, interpretation of the archeological resources of the Forest will, hopefully, become a major concern. We wish to explore the utility of the model for interpretive purposes. Second, there has been some considerable suggestion in the literature that sampling is useful for elucidating composition but not structure--that settlement pattern and social organization in a locational sense were unknowable through sample data. We wished to evaluate the empirical validity of this claim.

Their success in these analyses was considerable. In the course of carrying out the work, we realized that our organizational variables were also potentially significant pieces of information for cultural resource management. The utility of understanding variation in the density of sites is clear. The evenness of that distribution is also critical. Given a constant density, whether sites are relatively clustered or relatively dispersed will make avoidance more or less possible given some specific project. Similarly, agglomeration is a source of shorthand information on the largest sites and therefore, greatest problems that are likely to arise in different areas. Thus, what began as straightforward research resulted in the identification of some easily definable characteristics of site distribution that can be of great utility in the early stages of planning.

Conclusion

Cultural resource management and archeological methodology are plagued by an overabundance of speculation and a dearth of empirical research. We have speculated ourselves into incorrect beliefs about the techniques and interpretation of sampling. We have permitted concepts such as "indirect impact" to be defined ethereally when precise empirical definitions are a possibility given good empirical research. The need for strong and supportable information for the management of resources not only provides an opportunity to do research, it forces us to address questions that we should rightfully have addressed without any such stimulus.